CONTRIBUTI DI RICERCA CRENOS

GAS INDUSTRY REFORMS AND CONSUMERS' PRICES IN THE EUROPEAN UNION: AN EMPIRICAL ANALYSIS

Rinaldo Brau
Raffaele Doronzo,
Carlo V. Fiorio'
Massimo Florio

WORKING PAPERS

2008/16

CENTRO RICERCHE ECONOMICHE NORD SUD
(CRENOS)
UNIVERSITÀ DI CAGLIARI
UNIVERSITÀ DI SASSARI

Il CRENoS è un centro di ricerca istituito nel 1993 che fa capo alle Università di Cagliari e Sassari ed è attualmente diretto da Raffaele Paci. Il CRENoS si propone di contribuire a migliorare le conoscenze sul divario economico tra aree integrate e di fornire utili indicazioni di intervento. Particolare attenzione è dedicata al ruolo svolto dalle istituzioni, dal progresso tecnologico e dalla diffusione dell'innovazione nel processo di convergenza o divergenza tra aree economiche. Il CRENoS si propone inoltre di studiare la compatibilità fra tali processi e la salvaguardia delle risorse ambientali, sia globali sia locali.
Per svolgere la sua attività di ricerca, il CRENoS collabora con centri di ricerca e università nazionali ed internazionali; è attivo nell'organizzare conferenze ad alto contenuto scientifico, seminari e altre attività di natura formativa; tiene aggiornate una serie di banche dati e ha una sua collana di pubblicazioni.

www.crenos.it
info@crenos.it

CRENOS – CAGLIARI
VIA SAN GIORGIO 12, I-09100 CAGLIARI, ITALIA
TEL. +39-070-6756406; FAX +39-070- 6756402

CRENOS - SASSARI
VIA TORRE TONDA 34, I-07100 SASSARI, ITALIA
TEL. +39-079-2017301; FAX +39-079-2017312

Titolo: GAS INDUSTRY REFORMS AND CONSUMERS' PRICES IN THE EUROPEAN UNION: AN EMPIRICAL ANALYSIS

Gas industry reforms and consumers' prices in the European Union: An Empirical Analysis

Rinaldo Brau Università di Cagliari and CRENoS,
Raffaele Doronzo*, Carlo V. Fiorio, Massimo Florio

*Banca d'Italia, Department of Economics, Business and Statistics, University of Milan

Abstract

The paper offers an exploratory empirical analysis of the impact on consumers' welfare of the reforms of the gas industry in EU-15 area. After considering the key features of the natural gas industry and of its reform in selected countries, we study the relationship between regulatory reform indicators and price dynamics by means of panel data techniques. We find that none of the relationships between price dynamics and regulatory reform indicators is robust to different econometric specifications. Our findings suggest that until now there is limited evidence of beneficial effects of a standard package gas industry reforms for the European consumers. Country specific factors and price inertia seem to be more important than the reforms as determinants of consumers' prices.

Keywords: Natural gas industry, privatization, liberalization, regulatory reform.
JEL: L32, L33, L95

Acknowledgments: The research has been supported by the EU, 6th Framework Programme, UPP project: 'Understanding Privatization Policy: Political Economy and Welfare Effects'. The authors are grateful for helpful comments to participants in the 2008 commerce of the Siep, the Italian Society for Public Economics.

1 Introduction

The advent of regulatory reforms, including privatization, network unbundling, regulation and liberalization in many European and OECD countries is often seen as a key tool for fostering economic growth and welfare (see Nicoletti and Scarpetta 2003). It is pointed out that heavy regulated markets imply negative welfare effects since public ownership and some forms of regulation distort the allocation of resources between sectors and between firms, ending up affecting the overall economic performance.

One prominent goal of the European Union policy has been the attempt to implement regulatory reforms also into the energy industry, historically considered under conditions of natural monopoly. The provision of gas and electricity services at affordable prices is fundamental to increase the competitiveness of business and the welfare of household. In order to achieve this objective the EU came to the decision that radical reform both the in the gas and the electricity sectors had to be made.

In the last 15 years, these reforms have yielded a "new paradigm" characterised by a general consensus over the necessity to carry out some common measures for achieving a well functioning market-oriented industry"[1]. Namely, three parallel reforms have been called for: a) the privatization of the incumbents (sale of existing publicly owned firms and licensing of private entrants); b) unbundling, i.e. the separation of network segments of the industry from the potentially competitive ones, associated both with incentive regulation of the networks and establishment of independent regulatory bodies empowered at guaranteeing a non discriminatory access to the network infrastructures; c) liberalisation and development of a competitive environment by removing barriers to entry.

The implementation of this "paradigm" poses some challenges to policy-makers and industrial players, given that it is well known that large and integrated firms can often enjoy considerable economies of scope, scale or coordination depending on the degree of conglomerate, horizontal or vertical integration. This expected pursuit of efficiency may be at the expense of competition, in that large firms are likely to acquire a strong if not dominant market position, and productive and dynamic inefficiencies are likely to occur as a consequence. Energy sectors display considerable problems of this type, especially since in most cases their

[1] On this issue, see Jamasb and Pollitt (2005).

current set-up has its origin in a long tradition of state monopolies, where vertical integration was the preferred arrangement[2].

An extended empirical literature looking at macro-economic outcomes provides some support to a negative view of vertically integrated monopolies. For example Alesina *et al.* (2005) find that regulatory reforms in sectors which were characterised by competition (transport, communication and energy) have had a significant positive impact on own-sector capital accumulation. By contrast, the evidence of more direct positive effects is poorer. For example Barone and Cingano (2007), do not find significant effects on the growth of the industry added value when looking at aggregate measures of services liberalization. Moreover, a focus on macroeconomic aspects, which mixes the issue of privatization with that of liberalization, has partially obscured what has been one of the primary goals of EU policy on public utilities and services, i.e. fostering competition in order to provide consumers with lower prices and more freedom to choose.

Indeed, "the devil could be in the details", and even market liberalisation could not bring significant positive welfare effects (e.g. see van Witteloostuijna, Brakmanb and van Marrewijk, 2007, for an analysis of the Dutch natural gas industry). Detecting which specific reform intervention is more likely to positively affect citizens' welfare becomes crucial. As a matter of fact, some worries about the real effectiveness of the current patterns of regulatory reforms can no longer be concealed, and more articulated views such as that by the World Bank (2007) have appeared which, in comparison with the "EU paradigm", leave more degrees of freedom to national policy-makers. With a more direct focus on natural gas, some recent literature is being pointing out the lack of recognition by the "European model" of the very nature of the gas industry, whose transmission networks, differently from electricity and transport, are oligopolies rather than natural monopolies (Jamasb, Pollitt and Triebs, 2008), and where the presence of companies with market power in the upstream and retailer distribution phase could yield 'double marginalization' processes in case of unbundling of vertical stages (Davies and Waddams, 2007)[3].

---

[2]For a detailed history of nationalisation and consolidation in Europe see Millward (2005).

[3]A different stream of literature has looked at "micro-level" economic effects of privatization and liberalization at the firm level. See for example Omran (2004), Okten and Arin (2006) and the papers cited therein.

Differently from some of the existing literature, in this paper we focus on first round partial equilibrium impacts (as typically done by applied indirect tax reform literature). After all, if consumers at large do not benefit directly from reforms, it seems unlikely that indirect benefits to them through impacts on other industries, or benefits to other agents, can change dramatically the evaluation[4]. In order to achieve a conclusive policy assessment, one should undertake a welfare analysis based on detailed micro-data on household's expenditures, possibly with a decomposition of prices and quantities, and controlling for quality indicators of services such as access possibilities and contractual transparency. The key indicator for evaluating the success of public utilities reforms is consumers' price, possibly with micro-data.

Unfortunately, in order to undertake a cross-country analysis one needs to rely on average prices, with considerable information loss for those cases where there is price discrimination across types of contracts. Though, even if based on average prices, some simple policy questions can be made:

- are European consumers facing lower prices than they would do if no regulatory reform processes would had taken place?
- Given the plurality of tools which contribute to define service regulatory reforms, which are the specific policies that actually affect price dynamics and consumer's welfare?
- Given that liberalization is likely to be associated with transaction costs are effects on prices substantial or negligible?

In order to assess how regulatory reforms have affected price dynamics, we combine price and regulatory datasets. In this paper we use a set of regulatory reforms indicators (REGREF), an OECD regulatory database which collects some indicators of privatization, disintegration, liberalization of several services of general interest across some OECD countries (Conway and Nicoletti, 2006). Information on prices is, instead, recovered from two standard statistical databases, EUROSTAT

[4]Quite surprisingly, significant indirect effects of utilities reform in spite of small direct effects are found in a series of studies, (namely Copenhagen Economics, 2005; Alesina *et al.*, 2005; Barone and Cingano, 2007). It is difficult however to understand how it is possible to get significant aggregate impacts if direct effects are minimal. There is some risk of omitted variables bias in aggregate estimation.

and IEA. Both these institutes provide net-of-tax series which cover the period when the European reforms have been started[5].

The structure of the paper is the following one. The next section reviews some features of the natural gas industry and its reform in selected EU countries. Data availability and the relationship between regulatory reform indicators and price dynamics is studied in Section 3, whilst in Section 4 the presence of any robust empirical relationship is looked for by means of panel data techniques. Finally, Section 5 discusses the main results and concludes.

2 The reform of the natural gas industry in the EU-15

The natural gas industry is composed of different segments. The upstream phase includes exploration, extraction and production. The transportation system consists of a complex network of pipelines, designed to quickly and efficiently transport natural gas from its origin, to areas of high demand. Natural gas, like most other commodities, but differently from electricity, can be stored for an indefinite period of time. While some large industrial, commercial, and electric generation customers receive natural gas directly from high capacity interstate and intrastate pipelines, most other users receive natural gas from local distribution companies. Local distribution companies typically transport natural gas from delivery points along interstate and intrastate pipelines through thousands of miles of small-diameter distribution pipe. The retail segment is the last downstream phase of the industry.

The historical structure of the gas sector in Europe was that of a public owned vertically integrated monopoly. This kind of organization was justified on the ground that the traditional benefits from vertical integration were generally strengthened by the burden of the long-term costs in the upstream phase (gas contracts, infrastructure investments). The significance of these costs required to minimise the uncertainty to sell the gas purchased in international markets through vertical

[5]The strategy we adopt here is similar to the one used by Copenhagen Economics (2005) to estimate and forecast the impact of market opening policies on overall price and productivity changes and to use this forecast as input into their simulation model of the European economy. We use, however, a wider dataset and a more robust econometric approach. We maintain that panel data techniques are able to get rid off of the national idiosyncratic aspects and of common trends, so that the effects of changes in regulation regimes can be detected.

integration and public monopoly. A direct consequence of this circumstance has been the development of the so called *take-or-pay* contracts. This particular type of agreements, largely diffused in the gas international market, are signed between the owner of natural gas (often a large state owned firm from non EU countries) and a large buyer who imports the gas and then resells it wholesale. This contract is meant to leave the owner with some price risk[6], while the importer entirely bears the quantity risk (the risk not to be able to resell the gas purchased). The view of the European Commission is that, although these contracts pose serious problems to competition in retail supply, they do not necessarily require vertical integration. The importer and the seller may not be the same economic entity in the national market. By breaking up the import contract into several subcontracts, there are ways to guarantee the commitments that the importer has with the foreign producer firm without implying the creation of a dominant position in the national market.

Following this approach the European Commission has promoted the liberalization of the gas industry by establishing a common set of rules and principles through two different Directives in 1998 and 2003 (see Thomas 2005). These directives represent the milestones in the gradual but radical restructuring of the gas sector. They had initially set a mandatory market opening calendar giving the EU-15 member countries eight years to open their markets to competition. Subsequently the second directive stepped up the pace of liberalization in the move to establish a single European gas market.

The EU is neutral on privatization (full or partial), but *de facto* there has been an association in the policy trends in several countries between privatization, vertical disintegration and liberalization.

2.1 The EU gas directives

The first European gas directive was adopted in June 1998[7]. The directive lays down a set of common rules and procedures relating to the organization and functioning of the national gas sector. Its main objective was to establish a single European natural gas market integrated, competitive, and well regulated. The final purpose of the Commission was to give the right to freely choose the supplier to

[6]International prices may vary during the period in which contract conditions are set, even if usually the contracted terms are indexed to other energy prices.
[7] First European Gas Directive (98/30/EC).

household and industrial customers and to create a real market price for gas, based on the interaction between supply and demand.

The general principle promoted by the 1998 directive is the Third Party Access, by which the owner of the network is obliged to give access to all the delivery requests through the network by the production and sales operators, setting a cost reflecting and non discriminatory access price. Third party access alone of course cannot entirely avoid the distortion that the incumbent firm can create to foreclose the entry of new competitors. Some sort of separation of activities was therefore promoted, but leaving the member states the freedom to choose between different alternatives: from the most radical that prescribes proprietary separation of the monopoly activities from the competitive ones, to a milder legal separation, reached through the creation of different companies under a common holding, to the weakest version of accounting separation. The last indication of the directive is the opening of the demand side, through the notion of eligible customers, a client that has the right to seek the most convenient supplier. This type of client is identified by his yearly consumption and a timetable is set to widen the portion of liberalized demand by defining lower and lower consumption threshold.

On June 26, 2003, a second directive was adopted[8], which laid down a set of additional common rules for the creation of the internal natural gas market and abrogated that of 1998. It included new measures intended to advance legal deadlines for complete opening of national gas markets to July 1, 2004 for all industrial users and to July 1, 2007 for households[9]. The directive also reinforced the obligation to keep separate account. Moreover, member states are enabled to impose transparent, non-discriminatory public-interest obligations on undertakings operating in the natural gas sector, which may relate to safety, security of supply, regularity, quality and price of supplies, and environmental protection. The powers of regulatory authorities were also reinforced, particularly as regards the control of the level of transparency and competition on the market. Despite the provisions of the two European directives that imposed a progressive opening of the market for industrial and household consumers, the actual results were more

[8] Second European electricity and gas Directive (55/2003/EC).

[9]Unfortunately, the OECD indicators of regulatory reforms in the members' states that we discuss and use in the next section do not cover the implementation of this second directive.

limited.

A possible way to detect the level of competition in the gas market is to look at the percentage of eligible consumers that have effectively switched suppliers. Table 1 reports this information for the EU-15 at the end of 2004. The situation varies considerably across countries. In UK the percentage of large users that have changed supplier is very high (50%). The situation in Austria and Germany is opposite with a switching rate below 10%.

It is apparent that beyond the reach of EU legislation, real market opening is impeded by a number of obstacles. The European Union is striving to open up its downstream gas market despite the fact that its upstream sector, most of which is not subject to European regulation, is still controlled by a small number of market players[10]. Moreover the presence of *take or pay* contracts and long term relationship established prior to deregulation between producing countries and purchasers are now curtailing possibilities for short term exchange and opportunities for new entrants. As a result, in many cases a single shipper dominates the market and sells nearly all the gas available. To facilitate the entry of new gas supplier into the market and weaken the dominance of incumbent operators, some countries have introduced gas release programs whereby the incumbent must divest a portion of his portfolio of long-term contracts[11]. The development of competition in the industry is also hindered by technical constraints. The cross country gas exchange is limited by network congestion due to insufficiently interconnections between member states: capital expenditures in new gas

[10]Imports are highly concentrated in a small number of producing countries, located outside Europe. There is a structural lack of competition on the supply side, dominated by state-owned companies from producing countries outside the European Union, such as *Gazprom*, *Statoil* and *Sonatrach* which in 2005 together represented over 45% of the entire European supply. *Gazprom* is a company mainly controlled by the Russian state that possesses the world's richest natural gas reserves. Statoil is an integrated oil and gas company based in Norway. *Sonatrach* is the Algerian company active in research, transformation and transport of hydrocarbons.

[11]These procedures are not provided under the two directives, but the European Commission has already imposed a gas release program by way of compensatory measure in approving some mergers (for instance *E.ON-Ruhrgas* in Germany). In some case a gas release program has been imposed by the national legislation (England, Italy, Spain) and by certain regulatory bodies (France, Denmark, Austria).

infrastructure currently represent a missing key to the emergence of a truly competitive market.

Table 1: The EU-15 gas sector: switching rate at the end of 2004

Country	Legal market opening rate %	Real market opening rate %	
		Large Users	Households
Austria	100	9	0.5
Belgium	90	60	4
Denmark	100	30	<5
Finland	-	-	-
France	70	25	-
Germany	100	7	<2
Greece	-	-	-
Ireland	86	>50	-
Italy	100	30	35
Luxembourg	72	<5	-
Netherlands	100	30	2
Portugal	-	-	-
Spain	100	>50	5
Sweden	50	<5	-
UK	100	>50	47

Source: Commission of European Community (a), 2005

2.2 The natural gas market in EU-15: production, consumption and external trade

The evolution and the maturity of the gas market in the EU-15 differ considerably across countries. In some of them natural gas is steadily used as a primary source of energy while in others, due to the limited availability of internal resources and/or to the scarcity of interconnections, its use is very restrained. This frame clearly emerges if we look at table 2. The highest level of consumption is recorded in UK where natural gas has replaced oil as the main primary fuel and the rate of diffusion among the household consumers is very large (35% of total consumption). The second market in EU-15 is that of Germany where total consumption is slightly under UK but the share of household gas consumption is the same. Italy is the third largest natural gas consumer in Europe with a demand that has been steadily increasing in recent years.

France, Netherlands and Spain represent intermediate market in terms of consumption. The French gas market is mature in age but the share of natural gas in primary energy requirements is small if compared

to other mature market and growth is not expected due to the dominance of nuclear power. As regards the small and Nordic European countries, the picture varies considerably depending on the geographic position and on the availability of internal resources. While Austria, Denmark, Belgium Ireland and Luxembourg show a non negligible use of gas both in production stages and for household consumption, the same is not true for Greece, Portugal, Finland and Sweden where the diffusion of this source of energy is very small because of the limited interconnections and in some case by specific choices[12].

Table 2: The EU-15 gas sector: main data at the end of 2004

Country	*Internal production (TJ_gcv)*	*Total consumption (TJ_gcv)*	*Import dependency* (%)*	*Household consumption over total (%)*	*Imports from LNG over total (%)*
Austria	77550	357055	-78	19.5	0
Belgium	0	677290	-100	25.8	17.2
Denmark	395033	223311	43.5	14.6	0
Finland	0	183779	-100	0.6	0
France	51530	1807998	-98	28.5	20.4
Germany	685342	3750763	-82	35.2	0
Greece	1337	102462	-98.7	1.6	18.4
Ireland	32025	169708	-81	16.2	0
Italy	493813	3066058	-84	26	8
Luxembourg	0	111588	-100	10.5	0
Netherlands	2864924	1708444	40.3	21.5	0
Portugal	0	153733	-100	5.5	36.8
Spain	14398	1159510	-98.7	12	37
Sweden	0	41142	-100	4.8	0
UK	4019594	4087717	-1.6	35	0

Source: Eurostat 2006

Note: ** positive numbers indicate that the country is a net exporter*

Of course the use of natural gas and the dimension of national markets are also driven by the endowments of each country. The largest gas-field is located in UK and Netherlands. Germany, Italy and Denmark

[12]Greece, Finland and Portugal derogate from the provisions of the second European gas directive by virtue of their status as emerging or isolated markets. In Sweden nuclear power accounts for half of electricity supply. After the 1980 referendum to phase out all nuclear power plants by 2010, the government has given priority to renewable sources to fill the gap left by nuclear power and this choice has hampered the further development of the gas market.

have also some gas-fields but with more limited dimension. A consequence of this heterogeneity of endowments is a situation of strong import dependency. Among the 15 countries considered, only Denmark and Netherlands are net gas exporters. This situation raises the question of the security of gas supply which has been evaluated in a European directive of 2004[13]. At present, nearly all the gas imports into EU come from three countries – Russia, Norway and Algeria. Some European countries have undertaken the construction of new transport infrastructure, pipelines or liquefied natural gas facilities (LNG). In particular this last option seems to be very useful in order to enhance gas imports from new producing countries and to diversify the supply sources. Spain is the European country with the highest number of LNG terminal in Europe: 37% of total gas imports are transported by ship from very distant country such as Nigeria and Middle-East countries. The same approach was followed by France and Portugal where respectively 36% and 20% of total imports come from LNG terminals.
To illustrate the diversity of the industry, in the following sections we briefly sum-up the main features of the gas industry and reform process performed to implement the two gas directives in selected European countries. The countries analyzed are UK, France, Germany, Italy, Spain and Netherlands. As previously pointed out in the remaining nine countries there is a relatively limited diffusion of natural gas.

2.3 Reform trends

The opening of the gas market in UK was carried out well in advance of the requirements of the two EU directives. The process began with the Gas Act in 1986 which disposed for the privatization of the vertically integrated public monopolist *British Gas* and for the creation of a regulatory authority (*OFGAS*)[14]. The reform was concluded in 1998 when all domestic customers were given the right to choose in the supplier. In 1997 *British Gas* separated its retail division. It became *BG plc* and included the distribution and transmission network activities (*Transco*) while the smaller retail division, which had a small production

[13]European Directive 2004/67/EC concerning measures to safeguard security of natural gas supply.

[14]At present, the Regulatory body for the British energy industry (England, Wales and Scotland) is the Energy Markets Authority, which operates through the Office of Gas and Electricity Markets (*Ofgem*). This was produced in 2001 from the merger of the gas (*Ofgas*) and electricity (*Offer*) regulatory bodies.

division, but no network, became *Centrica*. In 2001 *BG plc* separate the *Transco* network division as a distinct company called *Lattice* but in 2002 it merged with the *National Grid Company* to become *National Grid Transco* (NGT). The regulator therefore required NGT to separate the distribution and transmission sector. The distribution network was split into eight different regional businesses and four of these were sold.

In contrast to UK, France was one of the latecomers in implementing the EU gas directives. The main texts governing activities related to gas are the 2003 and 2004 Energy Laws. These laws extended the powers of the French regulator in order to include also the electricity and gas sector. Furthermore they officially ensure the transposition of the legal unbundling obligation applicable to the Transmission System Operators (TSOs). Despite the adoption of the two directives and the legal separation implemented, the European Commission has evaluated that the unbundling of Gas industry in France remains still insufficient in order to avoid uncompetitive behaviours. In fact, the market opening is largely theoretical in France with a switching rate in the industrial segment not comparable with that of the UK.

Germany transposed the second European gas directive by the Energy Act of July 2005. According to the provisions of the directives the Act established a regulatory authority (the *Federal Net Agency*) with competences in the gas and electricity sector. Despite the official start of liberalization in 1998 the market is still suffering from a lack of liquidity in terms of both capacity and commodity. Only one gas retailer has a market share above 5% and the switching rate between industrial customers and household is very restrained (7% and about 2% respectively). This fact can be attributed to a number of reasons such as long term supply contracts in the internal market; contractual congestion in the pipeline preventing new market entrants from acquiring capacity; a certain hesitation of the large gas producers to sell gas to new market entrants; the not yet completed implementation of unbundling.

The first step towards the liberalization of the gas sector in Italy was the approval of Law 481 of November 1995 establishing the Italian regulatory Authority for Electricity and Gas (*AEEG*). At the same time, the partial privatization of the vertically integrated public monopolist *ENI* was performed. The transposition of the two gas directives was made by several legislative measures, taken in different occasions. The most relevant was the decree N. 164/2000 that gave a strong impulse to the creation of effective and increasing competition, liberalizing the

activities of importation, exportation, transportation and dispatching, distribution, and trade of natural gas.

Spain gas market is relatively recent and strongly growing. Overall consumption of gas has doubled from 2000 to 2005 with an 18% growth in 2005. The country has implemented important provisions following the two EU gas directives. Full market opening, including for domestic customers, and regulated third party access, also for gas storages are effective since January 2003. Ownership unbundling, at least partially, of gas transmission system operators was implemented, as well as legal and accounting unbundling of distribution system operators. An energy regulator exists since 1994 (*CNE*). However some important elements of the directives still have not been transposed and the adoption of the implementing legislation has constantly been delayed[15].

Netherland is the second EU-15 gas producer country. About half of its production is exported to France, Germany, Belgium and Italy. A gas regulator (*DTE*) was set up since 1998. The most important gas firm is *Gausnie*. This company was previously owned by the Dutch state (50%) and by *Exxon-Mobile* and *Shell* (25% each). On July 1 2005, *Gausnie* was formally split into two companies, a network company that will continue to be known as *Gausnie* and a purchasing and sales company for natural gas, *Gausnie Trade and Supply*. The Dutch state bought out *Shell* and *Exxon-Mobile*'s holding in the network company, while the ownership of the purchasing and sales company remains unchanged.

2.4 Market structures

Despite the European Commission advocates a single cross-country policy reform pattern, there is still a large variability in the national natural gas market structure among the EU-15 countries. This picture clearly emerges by looking at Tables 3 and 4 indicating the number of firms operating in the different segments of the gas industry and the type of unbundling for the TSOs.

In UK, the privatization of *British Gas* as a vertically integrated company prevented new entrants from came into the market for many years. However since the middle of the 90s the government required BG to progressively reduce its market share in the industrial market where it

[15]Spain is therefore the only member state with Luxembourg subject to general infringement procedure for non communication of transposition measures for both the gas and electricity directives, that are before the European Court (2007).

was replaced largely by oil companies. The main feature of the retail UK gas market is the progressive process of merge with the electricity market: all significant suppliers offer gas and electricity as a dual package. *Centrica* still holds about 60% of the residential gas market, with the rest of the market going to the five major electricity companies: *RWE/NPower*, *EON/Powergen*, *EDF*, *Scottish and Southern*, and *Scottish Power*. Britain is now facing a transition: from self-sufficiency in natural gas production it is becoming a net importer due to the declining internal production. To overcome this condition the country created the first trading connection with continental Europe via Belgium in 1998 and the links to Norway and Netherlands were successfully reinforced. Future projects include the creation of several LNG terminals in order to diversify the supply sources.

Table 3: The EU-15 gas sector: production, imports and retailing (around 2005)

Country	Production and Imports		Retailing	
	Number of entities bringing gas into the country (production or imports)	Number of entities dealing with at least 5% of natural gas (imported and produced)	Total number of suppliers	Suppliers having a share of at least 5% of the total
Austria	4	4	27	5
Belgium	4	2	32	2
Denmark	1	1	7	5
Finland	1	1	30	1
France	13	1	34	2
Germany	27	5	700	1
Greece	1	1	15	1
Ireland	7	5	2	2
Italy	26	3	389	5
Luxembourg	2	1	6	4
Netherlands	n.d	n.d.	25	4
Portugal	1	1	10	4
Spain	14	4	41	4
Sweden	1	1	7	5
UK	24	6	15	7

Source: Goerten and Clement (2006)

The gas industry structure in France parallels that in the electricity sector with one large company, *Gaz de France* (GDF)

dominating the market. It was fully public owned until July 2005 when 22% of the shares were sold by initial public offer. There are two TSOs in the country: *Gaz de France Reseau Transport* (GDF-RT) and *Total Infrastructures Gaz de France* (TIGF). They have been unbundled in legal terms. The main providers of natural gas are Norway (27% of total imports), Russia (21%), Netherlands (20%) and Algeria (12%). A relevant portion of French total import (about 20%) enters via LNG terminal. In the retail segment there is a limited competition: *Gaz de France* has not separated its retail activities and dominates the market for industrial and household consumers, while two new foreign companies (*British Petroleum* and *E.ON*) are attempting to enter the market.

Table 4: The EU-15 gas sector: type of unbundling for the Transmission System Operator

Country	Type of unbundling	Country	Type of unbundling
Austria	Legal	Italy	Legal
Belgium	Legal	Luxembourg	Not implemented
Denmark	Ownership	Netherlands	Ownership
Finland*	--	Portugal*	--
France	Legal	Spain	Legal
Germany	Partly legal	Sweden	Ownership
Greece*	--	UK	Ownership
Ireland	Not implemented		

Source: Commission of the European Community (b), 2006

***Note**: *countries that derogate from the provisions of the second European gas directive by virtue of their status as emerging or isolated markets*

The structure of the German gas market is characterized by a multi-tier structure containing five big companies at the import and transmission level, another 24 regional companies at transmission level, and approximately 700 companies operating at the local distribution level. *Ruhrgas*, with about 50% of the available gas dominates the market. It was taken over by *E.ON*, one of the two largest electricity companies in 2003[16]. The main competitors of *Ruhrgas* are *Wingas*, a company jointly owned by *BASF* and *Gazprom*, *RWE* the other large electricity company,

[16]The condition imposed by the German authority for allowing the take over included the sale of its stakes in a number of different gas companies and also it was required to auction a significant proportion of its gas import contracts to reduce its dominance on wholesale market.

VNG and *BEB*. The German gas transmission system is operated by the five big companies plus a number of regional transmission companies. Germany disposes of a relatively diversified gas supply portfolio, including domestic production (18% of total gas supply), imports from EU member states (22%), from Norway (26%) and from Russia (37%). All gas imports are through the five big companies.

The main participants in the Italian natural gas market are *ENI*, *ENEL, Edison, AEM, Hera, E.ON.* and *Gaz de France*. The biggest firm is still the former integrated monopolist *ENI*. The wholesale market is strongly dominated by *ENI* with 84% of domestic production and 65% of imports through five main infrastructures under its direct or indirect control[17]. An *ENI* subsidiary, *SNAM Rete Gas* (50% owned by *ENI*), owns and operates the domestic natural gas transportation system. According to recent legislation, *ENI* had to reduce its ownership to 20%. There are about 430 local distributors in the country, while in the retail market at the end of 2006, 380 companies owned a gas licence. Most of them represent unbundled sales division of formerly integrated distribution companies. However the market is strongly dominated by three largest groups: *ENI* with a market share of 40.3%, *ENEL* (15.8%), and *Edison* (7.9%).

In Spain the gas industry before liberalization was dominated by one integrated private company, *Gas Natural*. In 2002 the regulator authority forced the company to spin off 65% of the shares of *Enagas*, the private firm that controls Spain's natural gas transport system. The country imports all its gas mainly via pipeline from Norway and Algeria but with a significant proportion coming via LNG terminals from countries such as Qatar, Oman and Nigeria. Spain developed in recent years a quite competitive wholesale gas market. The government introduced a gas release programme which operated from 2001 to 2004 and resulted in six new entrants acquiring gas from the largest company *Gas Natural*. *Gas Natural* was forced to sell 25% of its contracted gas to new entrants to promote competition. After this process, the market share of the incumbent has reduced from 100% in 2000 to 48% in 2005. Despite the gas retail market has been fully open since January 2003 the overall setting is far to be considered as highly competitive. The

[17]TAG pipeline (mainly Russian gas), TENP pipeline (mainly Norwegian gas), Panigaglia LNG Terminal (mainly Nigerian and Algerian gas), TTPC pipeline (Algerian gas), Green Stream pipeline (Libyan gas).

switching rate since market opening is only about 5% and *Gas Natural* still strongly dominates the market for household with a share over 70%.

In the Netherlands the gas sector is still largely controlled by the incumbent *Gausnie*. The dominant position of the company is still largely unchallenged due to its strong position in terms of production. This is reflected by the modest share of small consumer that has switched the supplier since market opening in 2004 (2%). The frame in the industrial segment is slightly different with a cumulative switching rate of 30%. Retail and distribution is carried out primarily by the same locally owned companies as retail and distribute electricity.

3 EU gas reforms and consumer prices

A comparative analysis of the effects of a common policy reform on the European residential natural gas sector is a difficult task. As recently documented and studied for example by Asche, Nilsen and Tveteras (2008), apart from the common feature of very small short-run demand elasticities to own price and a dramatic consumption increase at an aggregate level, large differences across countries can be easily detected in terms of shares on total energy consumption and natural gas grid coverage. Such differences are so large that a very wide range of elasticity estimates arises at the single country level, and hamper the reliability of estimates based on cross-country homogeneity assumptions. Moreover, changes in crude oil prices have historically had a prominent role in shaping natural gas prices, symbolised by the existence of 'rules of thumb' for determining the price of natural gas starting from crude oil prices. Despite the fail of these rules in relating these prices for last years, even most recent studies detect strict relationships which indicate that natural gas and petroleum products are substitutes or at least closely related (Brown and Yücel, 2008; Hartley, Medlock and Rosthal, 2008)[18].

Given these structural constraints which are likely to hamper the overall effectiveness of common policy reforms, it is however interesting to look for the effects of EU attempts to reform industry in the last ten years. The main sources of price data we consider are Eurostat and International Energy Agency (IEA). The main reason for using also the latter source is that correlation between the two series is not very high (under 0.75), probably reflecting different aggregations of primary data at national level.

[18]In turn, this determines a close relationship with electricity prices. E.g., see Knittel (2003).

Data on prices we use are household net-of-tax prices, disentangling the tax component from the final price charged to domestic consumers. In particular, the IEA time series of natural gas for residential use starts in 1978 for most of the EU-15 countries and ends in year 2005. The EUROSTAT series started in 1991. In principle, the reference to net prices should allow for directly looking at any direct effect of regulatory reform on production prices. Eurostat prices refer to Gigajoules, whereas the unity measure for IEA is 10^7 KWs. We can get a first picture of price dynamics in the main European national markets from Figure 1[19]. It is evident that common shocks determine most of price variation in current terms. No particularly converging process seems to be in place in the period considered.

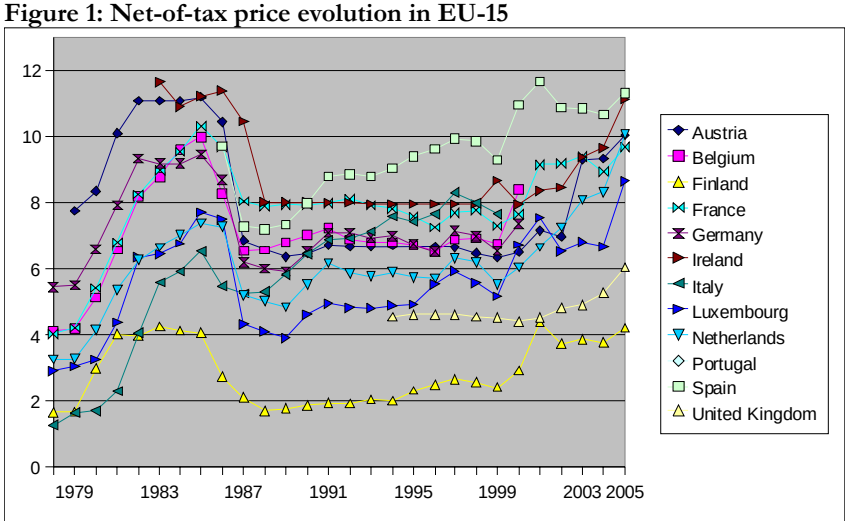
The regulation indicators in service sectors which we use in this paper come from the REGREF data set (for details, see Conway and Nicoletti, 2006). Sector-level data are available for the following service industries: electricity, natural gas, road freight, air passenger transport, rail transport, post and telecommunications. All the regulatory indicators range on a common (0-6) scale from least (0 corresponding to full deregulation) to the most restrictive conditions for competition. In principle, several aggregate regulation measures can be created starting from intra-sector indicators (e.g., see Alesina *et al.*, 2005), but in most cases one has to rely on the forced "cardinalisation" into the 1-6 scale of some ordinal characteristics[20]. This operation could be somewhat controversial, however, in several cases. For instance, while there is a

[19]Though the European Directives regarded the EU-15 countries, henceforth we are always excluding from the analysis Greece, Portugal and Finland, due to their nature of limited or isolated markets and the absence of complete time series in the two abovementioned data sources. Moreover, IEA data lack information on Sweden, whilst EUROSTAT does not provide complete series for Denmark.

[20]See the appendix for details. As for the natural gas market, the intra-sector REGREF indicators present the variable "public ownership", coded from 0 (complete private ownership in the production/import, transmission and supply phases) to 6 (public ownership for all), the variable "vertical integration", coded from 0 (vertical separation in all phases) to 6 (vertical integration for all), the variable "entry regulation", which is a weighted average of legal conditions of entry in a market and is coded from 0 (free entry) to 6 (franchised to one firm), and the variable market structure, coded from 0 (no firm has a market share above 50% in either the production/import, transmission or supply phase) to 6 (the same firm has a share above 90% for each phase).

clear ordering between private, mostly private, mixed, mostly public and public ownership, one may wonder whether coding these different options by means equally spaced values between zero and six may affect the results [21].

Figure 1: Net-of-tax price evolution in EU-15



Source: (IEA)

Although REGREF indicators provide a long yearly time series starting in 1975, we only consider years after 1991 due to the limited availability of comparable price information and the lack of institutional changes before the Nineties. This choice is also motivated by the acceleration of the European integration process following the signing of the Maastricht's Treaty in the Nineties. Even the EU directives on network utilities can be seen as part of this process. Overall, stronger integration among European economies should increase the reliability of cross-countries comparisons such the one carried out here. By looking to the data reported in Table 5, the consideration of this period only seems a natural choice given that no indication of regulatory reform is detected by the REGREF indicators before 1994.

The last year contained in REGREF indicators is 2003. Overall, we can therefore make use of an unbalanced panel composed of 13

[21]For details on the aggregation methodology followed by Conway and Nicoletti (2006), see Table A1.

years. Most of missing observations concern price variables, which are not available for a few countries where the market is limited. By excluding the above cited countries the minimum length of time series used in the empirical analysis is 7 years. The trend across the EU-15 countries (towards reduction of public ownership, a less vertically integrated industry structure and a less regulated access to the market) is strongly affected by the 1998 European directives, as can be easily verified in Table 5, where the average REGREF indicator for the gas sector are reported. Clearly, there is a downward trend, but some heterogeneity across countries and across time remains.

Table 5: Evolution of the average REGREF indicator in the natural gas industry

Country	1975	1994	1999	2003
Austria	4.5	4.5	4.5	2.7
Belgium	4.7	4.7	3.7	2.6
Denmark	5	4.5	4.5	3.2
Finland	4.5	4.5	4.5	4.5
France	6	6	6	4
Germany	2.5	2.5	1.5	1.5
Greece	6	6	6	5.2
Ireland	6	6	5.4	4.1
Italy	5.2	5.2	4.7	2.4
Luxembourg	4.5	4.5	4.5	3.4
Netherlands	4.5	4.5	4.2	2.9
Portugal	5.5	5.5	5.5	4.1
Spain	4	4	3.2	2.5
Sweden	3.7	3.7	3.2	2.7
UK	5.8	3.3	1.9	1.7

Source: REGREF (Conway and Nicoletti, 2006)

In Table 6 we make a step forward by showing the gas industry regulatory framework and (net of tax) consumer prices across the EU-15 for some selected years between 1991 and 2003. The table is organised using the REGREF classification of reform status, which provides a measure of the degree of public ownership, vertical integration, entry regulation and market structure of national gas industries in the EU-15. In this table we distinguish between three possibilities of ownership of the industry (mainly public, mixed, mainly private), which can be

associated to one out of three possibilities of vertical integration of the network (integration, legal/accounting separation, or ownership separation), one out of three possibilities of market entry (free, partly free, no free entry) and one out of three market structures (the market share of the incumbent can be more than 90 percent, less than 50 per cent, or somewhat in between). Each cell contains the countries being characterised by a particular combination of ownership, vertical integration, market structure and entry regulation in a given year and the (net of tax) consumers' price as percentage deviation from the EU-15 average, which is reported in the last line of the table and is expressed in current Euro (or ECU). The first and last year considered are 1991 and 2003 as Eurostat price data are not available for earlier years and REGREF indicators are not available after 2003.

Focussing on the polar cases, five countries (Ireland, France, Greece, Portugal, Italy) in the early 1990s were vertically integrated public monopolies. Their prices deviate from the average in very different ways, with Italy showing very high (net of tax) relative prices, France close to the average, Ireland in between. France remains the country where privatization and liberalization reforms have had a smaller impact, however consumers' prices has always been close to the EU average. At the other extreme, in the UK, since 1985 under private ownership, gas prices have been lower than the EU average and prices seemed to fall even more following full liberalisation. During the same period, the Netherlands had a private vertically integrated industry and prices were well below the average. In Spain, however, private ownership with limited entry was associated with very high relative prices, at levels similar to those of Italy. In Germany, a mostly private gas industry seems to be associated with lower prices in early 1990s than in more recent years, when prices tend to converge to the EU average and to be marginally higher. Under mixed public-private ownership Luxembourg over the years shows significantly low gas prices under vertical integration, even lower than in the UK. Denmark, under public ownership until recent years, has in most years consumer's prices below the EU average. Thus, it is not self evident that prices in some combinations of industry reform, are systematically lower or higher than the average. It seems that other country features are important, because the transition from one regime to another has a limited impact over time in the country's price performance. To explore this issue, we need to explicitly account for specific country features.

Table 6: The regulatory framework and gas prices. Selected years, in EU-15

PO	VI	ER	MS	1991	Pr 91	1995	Pr 95	2000	Pr 00	2001	Pr 01	2002	Pr 02	2003	Pr 03
Public	Integr.	No free	>90%	IR	12%	GR		GR		FR	-8%	FR	5%		
				FR	-1%	IT	17%	FR	-6%						
		Partly		GR		PT									
				PT		GR									
				IT	38%	FR	7%								
				BE	-4%	IR	6%	IR	-2%	IR	-				
		Free	50-									IR	-		
	Legal/ Acc. Separ.	Partly	>90%			DK		DK	21%						
		Free												FR	2%
			50-											IR	-
	Own. Separ.	Partly	>90%							DK	19%				
		Free										DK	- 14%	DK	-6%
Mixed	Integr.	No entry						IT	19%	PT	49%	PT	51%		
								PT							
		Partly		LU	-	AU									
				AU		LU	-								
		Free						AU	5%						
	Legal/ Acc. Separ.	Partly								IT	20%				
		Free entry								AU	-5%	AU	0%		
			50-									IT	14%	AU	0%
	Own. Separ.	No entry	>90%											PT	43%
		Free entry	50-90%											IT	11%
Private	Integr.	No free	>90%	NE	-	NE	-								
			50-	SP	32%	SP	29%								
		Partly		FI		FI	-	LU	-	FI		FI		FI	
		Free	>90%	SW		SW		FI							
				UK	-9%	BE	3%								
						UK	-	BE	0%	LU	-	LU	-	LU	-
	Legal/ Acc. Separ.	No free entry	50-90%												
		Partly						SP	23%	SP	20%				

		<50%	GE	-17%	GE	7%								
	Free entry	>90%					SW	3%	NE	-	SW	10%	SW	11%
							NE	-	SW	-1%	NE	-	BE	-3%
									BE	3%	BE	-5%	NE	-8%
		50-90%					UK	-	UK	-	UK	-	SP	17%
							UK	-	UK	-	SP	19%	UK	-
		<50%					GE	-6%	GE	5%	GE	5%	GE	1%
Av. current prices for EU-15			EU15	7.28	EU15	6.72	EU15	7.41	EU15	9.21	EU15	8.76	EU15	8.88

Notes: 1991 means year 1991. Pr 91 means price in year 1991, when available. The other labels are interpreted similarly. Numbers show the percentage difference from the average EU-15 (using available data).

Source: Conway and Nicoletti (2006) for regulatory reform data and Eurostat (data downloadable from http://ec.europa.eu/eurostat/) for gas price data.
Legenda: PO=Ownership (public, mixed, private), VI=vertical integration (integration, legal/accounting separation, ownership separation), ER=entry regulation (Free, partly free and no free entry), MS=market structure (less than 50%, between 50% and 90%, over 90%).

BE=Belgium, DK=Denmark, GE=Germany, GR=Greece, IT=Italy, SP=Spain, FR=France IR=Ireland, LU=Luxembourg, NE=Netherlands, PT=Portugal, UK=United Kingdom, FI=Finland SW=Sweden, AU=Austria.

4 Empirical analysis

In this section we estimate panel data models where natural gas prices are expressed as a function of the regulatory variables. Our aim is to test for the impact of the REGREF indicators on net-of-tax levels of natural gas prices faced by European households. As mentioned, for our empirical investigation we have used both the price data provided by IEA, and those provided by Eurostat.

We have first explored the datasets by means of within-group and first differences estimators with time dummies, since these simple analyses have been the basis of some existing works which use the REGREF indicators[22]. Both prices series are expressed in Gigajoules.

A within group estimator should provide results very similar to the first difference model where strong exogeneity and lack of measurement error hypotheses holds (Arellano, 2003). But as Table 7 shows, strong differences between the two models exist. It turns out that the price effects estimated via basic fixed effect analysis (which,

[22]E.g., see Barone and Cingano (2007).

incidentally, does not display significant relationships between regulation indicators and prices) cannot be considered sufficiently robust so as to draw clear indications[23].

Table 7: Least Square Dummy Variable and First Differences Estimates

Dependent variable: (net of tax) price of natural gas for households	IEA PRICES		EUROSTAT PRICES	
Control variables	FE estimates	FD estimates	FE estimates	FD estimates
Vertical Integration	0.840	1.198	0.160	-0.141
st-error	*0.777*	*0.857*	*0.105*	*0.135*
Public Ownership	-0.385	0.052	0.004	-0.049
st-error	*0.589*	*0.896*	*0.081*	*0.139*
Entry Regulation	0.013	-0.200	-0.061	0.035
st-error	*0.492*	*0.506*	*0.065*	*0.073*
Market Structure	-1.607	-0.396	0.437***	0.092
st-error	*1.139*	*1.416*	*0.157*	*0.208*
Constant	11.181*	-1.040	6.651***	-0.131
st-error	*6.494*	*1.348*	*0.890*	*0.207*
No of obs	130	129	132	121

Note: ** p<0.10, ** p<0.05, *** p<0.01*

We consequently move to considering dynamic and instrumental variable specifications, which on the contrary are able to account for more general assumptions on unobservable heterogeneity components[24]. As is well known, the seminal contribution for this kind of models is the GMM approach by Arellano-Bond (1991), followed by a series of refinements such as the "system GMM" by Arellano-Bover (1995) and Blundell-Bond (1998).

[23]Due to the limited market size or the lack of sufficiently long time series, observations referred to Denmark, Finland, Portugal and Greece have been excluded from the analysis.

[24]An additional problem of a simple FE specification is that it is more exposed to spurious regression problems related to the presence of unit roots in the time series which compose the panel. In order to reduce this problem, henceforth we consider price variations as dependent variables.

The model we estimate is the following dynamic specification, where the lagged dependent variable has been used as an additional regressor. Let p_{it} be the yearly household natural gas prices for country *i* at time *t*, R_{it} the vector of regulatory variables for country *i* at time *t*, Z_{it} a vector of additional controls, and β a vector of time dummies:

(1) $$p_{it} = \rho p_{i,t-1} + R_{it}^{'}\gamma + Z_{it}^{'}\delta + \alpha_i + \beta_t + \varepsilon_{it},$$

where $\alpha, \beta, \gamma, \delta, \rho$ are parameter vectors to be estimated and ε_{it} is an iid (over *i* and *t*) disturbance term.

In this model, time dummies can account for common shocks on consumer prices and oil prices, and following the Arellano-Bond (1991) article are considered strict exogenous variables. As for the additional controls in the Zit vector, their inclusion is aimed at assessing the robustness of the results to the presence of (time-variant) country effects which cannot be eliminated via first differencing. We have considered both sector-specific variables (namely national gas production, gas imports and gas exports) and macroeconomic indicators (per-capita GDP and consumer price dynamics). In addition, given the aforementioned relationship between natural gas and crude oil prices, the "Brent" series provided by the IEA has been included.

As for the ρ parameter, which captures the correlation between current and lagged price variations, we must recall that one does not need to interpret it as a real structural parameter, given that in dynamic panel data analyses its estimated value subsumes the combined effect of true state dependence effects and correlation over time due to unobserved heterogeneity (Cameron and Trivedi, 2005). In the case of feedstock prices, it is likely that true state dependence is actually small, so that a dynamic panel specification becomes a way to capture the effect of country-specific unobservable factors such as access to different pipelines with different import prices and the presence of different *take-or-pay* contracts.

As it is well-known, with panel data estimation the inclusion of a lagged dependent variable entails an endogeneity problem which yields inconsistent estimates of traditional random effects, fixed effects and first differences estimators. Consistent estimates can be obtained via approaches such as the GMM first difference estimator by Arellano and Bond (1991). More efficient estimates are obtained by means of the "system-GMM" by Arellano-Bover (1995), provided that the orthogonality condition $E[\varepsilon_{it} p_{is}] = 0$ for $s \leq t-1$ holds.

The results from applying the system-GMM approach for the estimation of equation (1) are reported in the following Table 8,[25] where again both datasets have been considered. In order to try to contain the risk of "redundant number of instruments" problems, we arbitrarily contain the order of admitted lags to t-2.[26] Standard autocorrelation and over identification test are reported in the bottom part of the table[27]
Table 8 shows that the only common qualitative result common to both datasets is the (as expected) statistically significant effect from the lagged dependent variable. Columns (a) and (c) report the results from regressions where only the REGREF indicators and the time dummies have been considered. No significant effects from the regulatory reform variables could be detected in this case. On the contrary, when adding to the specification the country-specific controls "domestic gas production", "gas exports" and "imports", "gross domestic product (all in per-capita terms) and the "consumer price index", there is evidence that public ownership is associated to lower prices. Incidentally, crude oil price is always significant, but the size of the estimated coefficient is not so high to account for most of the variability of the dependent variable.[28]

[25]In the regressions we are presenting the number o the instruments has been kept relatively low so as not to hinder the reliability of Sargan over identification and Arellano-Bond autocorrelation tests. The quality of the results does not change when allowing for a wider set of instruments based on higher lag orders.
[26]It is well known that dynamic panel data models usually produce lots of instruments, whose overall affordability is tested via the Sargan's over identification statistic which, however, is sensible to the losing of degrees of freedom.
[27]GMM estimators are valid only if there is no serial correlation in the errors. Including time dummies as exogenous regressors contributes to ensure this condition. Since the first difference of a white noise process is necessarily auto correlated, only second order autocorrelation test are reported.

[28] Moreover, all the regressions are robust to the inclusion/exclusion of this variable.

Table 8: Dynamic regressions with aggregate REGREF indicators

Dependent variable: net of tax price of natural gas for households	IEA PRICES System-GMM sample:1991-2003 (a)	(b)	EUROSTAT PRICES System-GMM sample:1991-2003 c	(d)
Control variables				
Lagged dependent variable	0.8344 ***	0.5520 ***	0.664 ***	0.3950 ***
robust st-error	*0.1167*	*0.0637*	*0.050*	*0.1431*
Vertical Integration	0.0361	0.1213	-0.054	-0.1114
robust st-error	*0.0885*	*0.1272*	*0.095*	*0.0994*
Public Ownership	-0.0661	-0.1469 *	-0.102	-0.1016 **
robust st-error	*0.1013*	*0.0942*	*0.083*	*0.0512*
Entry Regulation	-0.0381	0.0353	0.078	0.1146 **
robust st-error	*0.0620*	*0.0935*	*0.065*	*0.0557*
Market Structure	-0.2788	-0.1525	0.099	-0.0639
robust st-error	*0.1998*	*0.2001*	*0.247*	*0.1850*
Per capita indigenous production		-0.0007		-0.0008 **
robust st-error		*0.0012*		*0.0003*
Per capita imports		-0.0005		-0.0006 ***
robust st-error		*0.0004*		*0.0001*
Per capita exports		-0.0002		-0.0005
robust st-error		*0.0002*		*0.0004*
Consumer Price Index		0.0252 ***		-0.0835
robust st-error		*0.0096*		*0.0646*
Per-capita GDP		0.0024		0.0020
robust st-error		*0.0209*		*0.0054*
Brent oil price		0.0820 ***		0.1355 **
robust st-error		*0.0149*		*0.0537*
Constant	3.1258 ***	0.4741	2.906 ***	12.0364 *
robust st-error	*1.3514*	*1.6944*	*0.935*	*7.5025*
Observations	**107**	**107**	**121**	**121**
A-B 2nd order autocorrelation test	-1.822	1.705	-0.889	-0.445
Prob.	*0.068*	*0.088*	*0.374*	*0.656*
Sargan's overidentification test	39.54413	38.111	29.282	31.509
Prob.	*0.2742*	*0.374*	*0.555*	*0.441*
Number of instruments	52	58	48	53

Note: ** p<0.10, ** p<0.05, *** p<0.01*

An additional check is to see whether the results provided by the composite original REGREF indicators are kept or reversed when considering more "objective" regulatory indicators, which can be immediately referred to the structure or the market of the gas industry.

In particular, here we go into further detail by directly considering the "sub-components" used by the OECD for creating their composite indicators ranging between 0 and 6:

- As far as the public/private ownership dimension, the continuous variables available are the percentage of shares

owned by the state in the import, export or production stage (henceforth PUBLIC-PROD) and the distribution stage (PUBLIC-DIST)[29].

- As for liberalisation, a continuous variable which can be used is the percentage of the retail market open to consumers' choice (OPEN-CHOICE). Moreover, a dummy variable can be created for those cases where the market share of the incumbent is below 90%.
- Regarding unbundling, we do not consider a proper procedure transforming into a cardinal or ordinal scale the presence of an integrated monopoly, legal/accounting separation or ownership separation. We therefore created dummy variables for those cases where distribution is separated from supply, there is ownership separation and or legal/accounting separation in the import/production and in the supply segment[30].

The results obtained by considering the aforementioned new variables instead of the composite REGREF indicator are reported in the Table 9. As can be seen, for the regulatory variables we have not been able to find any significant (positive or negative) effect which can be considered robust to the different specifications and datasets.[31]

In the single cases where significant coefficients have been detected, the results sometimes go in an opposite direction with respect to the common view. Eurostat gas prices seem to increase more the higher the market share open to consumers, and for IEA prices a similar effects has been captured by means of a dummy for those markets where the incumbent share is lower than 90%.

[29]There exist also a third variable related to the percentage of share owned by the state in the transmission industry, but for most countries is nearly collinear with the variable related to production.

[30]Up to 2003, in too few cases ownership separation was detected.

[31]In addition to the specifications presented, we could easily implement other regressions where only the significant $Z_i s$ have been inserted. These regressions, available on request, only slightly improved the statistical significance of the (remaining) included variables.

Table 9: Effects of "genuine" regulatory reform indicators on natural gas price dynamics

Dependent variable: net of tax price of natural gas for households	IEA PRICES System-GMM sample:1991-2003 (a)		IEA PRICES System-GMM sample:1991-2003 (b)		EUROSTAT PRICES System-GMM sample:1991-2003 c		EUROSTAT PRICES System-GMM sample:1991-2003 (d)	
Control variables								
Lagged dependent variable	0.6368	***	0.4418	***	0.604	***	0.3755	***
robust st-error	*0.1450*		*0.0996*		*0.064*		*0.1102*	
Public share in production	0.0008		0.0029		-0.002		-0.0027	
robust st-error	*0.0053*		*0.0035*		*0.001*		*0.0030*	
Public share in distribution	-0.0025		-0.0105		-0.006		-0.0109	
robust st-error	*0.0091*		*0.0074*		*0.008*		*0.0072*	
Market share open to consumers	0.0032		0.0025		0.004	**	0.0020	
robust st-error	*0.0023*		*0.0024*		*0.002*		*0.0018*	
Dummy for vert. separ. in production	-0.1801		-0.0197		-0.082		0.1280	
robust st-error	*0.3189*		*0.1833*		*0.355*		*0.4573*	
Dummy for vert. separ. in supply	0.0390		0.0932		-0.285	*	-0.0343	
robust st-error	*0.4113*		*0.4076*		*0.165*		*0.1825*	
Dummy for vert. separ. in distribution	0.2191		-0.2487		0.238		0.0231	
robust st-error	*0.4490*		*0.4111*		*0.288*		*0.2961*	
Dummy for share incumbent <90%	1.4784	***	1.0829	*	-0.220		-0.3475	
robust st-error	*0.4637*		*0.5617*		*0.449*		*0.4302*	
Per capita indigenous production			-0.0013				-0.0010	**
robust st-error			*0.0010*				*0.0005*	
Per capita imports			-0.0007	**			-0.0008	***
robust st-error			*0.0003*				*0.0002*	
Per capita exports			0.0000				-0.0003	*
robust st-error			*0.0001*				*0.0002*	
Consumer Price Index			0.0239	***			-0.0495	
robust st-error			*0.0117*				*0.0574*	
Brent oil price			0.0525	***			0.1035	**
robust st-error			*0.0155*				*0.0487*	
Per-capita GDP			0.0002				0.0019	
robust st-error			*0.0238*				*0.0052*	
Constant	2.4072	**	1.7240				9.3970	*
robust st-error	*1.1117*		*1.2572*				*5.5324*	
No of observations	**107**		**107**		**121**		**121**	
A-B 2nd order autocorrelation test	-1.219		-1.352		-1.015		-0.857	
Prob.	*0.223*		*0.176*		0.310		*0.391*	
Sargan's overidentification test	35.809		40.900		28.279		31.995	
Prob.	*0.4303*		*0.264*		0.607		*0.417*	
Number of instruments	55		61		51		56	

Note: ** p<0.10, ** p<0.05, *** p<0.01*

In addition to the results reported in the table, no significant effects could be detected also when considering for non linear

relationships by means of quadratic terms, as for example it is done in Alesina *et al* (2005) by using the REGREF indicators "cardinalized" within the 0-6 scale. Other specifications have been studied where the logarithm and the variation of prices have been considered as dependent variables, still without obtaining any robust and conclusive evidence on the response of prices to regulatory changes.

Finally, let us also stress that fixing 1991 as a starting period of this additional analysis is of course an ad hoc choice, mainly driven by the correspondence with the Eurostat time series. We have however verified that as far as the regulatory variables are concerned, results are quite robust for any starting year of the panel between 1990 and 1995. In contrast, there appears a decrease in the importance of the additional control variables, as the process of European integration proceeds.

5. Conclusions

Our empirical analysis of the impact of regulatory reforms on prices in the EU natural gas households markets has been unable to find any significant effect. The impacts of the reforms, as far as captured by standard econometric modelling, seem to be small or elusive, and sometimes tend to be different from what could be expected under the 'paradigm' (for example some results about public ownership and market entry).

Further research is needed to understand why the effects we observe are so small and their determinants quite elusive. A critical aspect is to be related to the short T and N dimension of the panels we used. On the one hand, a large T is required for consistency when introducing the lagged dependent variable. In our case T is at most equal to 12 for a few countries, but it must be pointed out those variations in regulatory reform indicators started in 1994. On the other hand, it is well known that GMM methods in differenced form, as those used in our empirical analysis rely on a large N for consistency, and this is not certainly the case with at most 12 countries included in the sample. However, the above mentioned problems are of course shared by any other studies on the gas industry in EU.

On the whole, we regard our findings as preliminary evidence that -up to now- there is limited empirical support for the welfare dominance of a standard reform package across the EU.

For the natural gas market, the combined use of composite indicators and simple regression models could lead to misleading results. Disaggregate indexes of regulatory reform fail however to detect any

significant effect. We conclude that available data, at least at present, do not support the view that consumer's prices of natural gas are lower in the EU countries that have privatized, unbundled, and liberalized the industry than in those that have not undertaken the standard reform package.

References

Alesina A., S. Ardagna, G. Nicoletti and F. Schiantarelli (2005), *Regulation And Investment*, Journal of the European Economic Association, MIT Press, vol. 3(4), p 791-825.

Arellano, M. and S. Bond (1991)**,** *Some test of specification for panel data: Monte Carlo evidence and an application to employment equations*, Review of Economic Studies, vol. 58, pp. 277-298.

Arellano, M. and O. Bover (1995). *Another look at the instrumental variable estimation of error-components models*. Journal of Econometrics, 68: 29-51.

Arellano, M. (2003) Modelling Optimal Instrumental Variables For Dynamic Panel Data Models, Working Paper wp2003_0310, CEMFI

Asche, F., Nilsen, O. B. and Tveteras R. (2008) *Natural Gas Demand in the European Household Sector,* The Energy Journal, 29, No 3.

Barone, G. and Cingano, F. (2007), *Services regulation and growth: evidence from cross-country data*, mimeo, Banca d'Italia.

Blundell, R. and S. Bond (1998)**,** *Initial conditions and moment restrictions in dynamic panel data models*, Journal of Econometrics, vol. 87, pp. 115-143.

Brown S.P.A. and M.K. Yücel (2008), *What drives natural gas prices?*, The Energy Journal, 29, No 2.

Cameron, A.C. and P.K. Trivedi (2005) *Microeconometrics, Methods and Applications,* Cambridge University Press.

Commission of the European Community (a) – General Direction for Energy and Transport *Report on progress in creating the internal gas and electricity market*, Bruxelles, 2005

Commission of the European Community (b) – General Direction for Energy and Transport *Report on progress in creating the internal gas and electricity market* – Technical annex, Bruxelles, 2006

Commission of the European Community (c) – General Direction for Energy and Transport *Study on unbundling of electricity and gas transmission and distributors operators* – Technical annex", Bruxelles, 2006

Commission of the European Community (d) – General Direction for Energy and Transport *Prospect for the internal gas and electricity market: implementation report*, Bruxelles, 2007

Conway, P. and G. Nicoletti (2006), *Product market regulation in non-manufacturing sectors in OECD countries: measurement and highlights*, OECD Economics Department Working Paper.

Copenhagen Economics (2005), *Market Opening in Network Industries*, Report by Copenhagen Economics on behalf of DG Internal Market, EU Commission, downloadable from http://www.copenhageneconomics.com/publications/.

Davies, S. and Waddams, C. (2007), *Does Ownership Unbundling Matter? Evidence from UK Energy Markets*, Intereconomics, 42(6), 297-301.

Goerten J. and E. Clement (2006) *European gas market indicators of the liberalisation process 2004 –2005*, Eurostat

Hartley, P. R., Medlock, K. B. and Rosthal, J. E. (2008), *The Relationship of Natural Gas to Oil Prices,* The Energy Journal, 29, No 3.

International Energy Agency (2006)**,** *Natural gas information***,** IEA Statistics

Jamasb T. and M. Pollitt (2005). Electricity Market Reform in the European Union - Review of Progress toward Liberalization & Integration, CEEPR Working Papers 05-03, Massachusetts Institute of Technology,

Jamasb T., M Pollitt and T. Triebs (2008). *Productivity and efficiency of US gas transmission companies: A European regulatory perspectiv*e, Energy Policy, Vol 36, pp. 3398-3412.

Knittel C. R. (2003). *Market structure and the pricing of electricity and natural gas*, Journal of Industrial Economics, Vol. 51, pp. 167-191.

Millward R. (2005), *Private and public enterprise in Europe: Energy, telecommunications and transport c. 1830-1990*, Cambridge University Press.

Nicoletti, G. and S. Scarpetta (2003), *Regulation, Productivity and Growth: OECD Evidence*, Economic Policy, vol. 18(36), pp. 9-72.

Okten, C. and K.P. Arin (2006). *The effects of Privatization on Efficiency: How does privatization work?*, World Development, Vol. 34, pp. 1537-1556.

Omran, M. (2004). *The performance of state-owned enterprises and newly privatized firms: Does privatization really matter?* World Development, Vol. 32, 1019-1041.

Thomas S. (2005), *The European Union gas and electricity directives*, European Federation of Public Service Unions (EPSU).

Van Witteloostuijna A., Brakmanb S. and, van Marrewijk C. (2007), *Welfare distribution effect of a price reduction in the Dutch gas transport market: A scenario analysis of regulatory policy, market form and rent allocation*, Energy Policy, 35, 6299–6308.

Appendix A: The REGREF dataset

The REGREF regulatory dataset has been created by the OECD.[32] It collects information about indicators of privatization, liberalization and disintegration of services of general interest across the OECD countries for 18 years from 1975 to 2003. As regard the gas sector the database provide information about four dimensions: public ownership, vertical integration, entry regulation and market structure.

-*Entry regulation*: this series is an indicator of legal conditions of entry in the market and it is coded between 0 (free entry) to 6 (one firm). It is a weighted sum of four different sub index each with equal weight, namely: terms and conditions of third party access (TPA) to the gas transmission grid; existence of national, state or provincial laws or other regulations restricting the number of competitors allowed to operate in the gas production/import segment; percentage of the retail market open to consumer choice.

-*Public ownership*: this series indicate the ownership structure of the largest companies in the production/import, transmission and distribution segments of the gas industry. The variable is coded between 0 (private ownership) to 6 (public ownership).

-*Vertical integration*: this series is a weighted average of three indicators of vertical separation between different segments of the industry. It is coded between 0 (vertical separation in all phases) to 6 (integration for all). The components of the index, each with equal weight, are: degree of vertical separation between gas production/import and the other segments of the industry; degree of vertical separation between gas supply and the other segments of the industry; existence of vertical separation between distribution and gas supply.

-*Market Structure*: this variable is coded from 0 (no firm has a market share above 50% in each segment of the gas industry) to 6 (the same firm has a market share above 90% in each phase). It is composed by three different sub-indexes: market share of the largest company in the gas production/import stage; market share of the largest company in the gas transmission stage; market share of the largest company in the gas supply stage.

[32] See Conway and Nicoletti (2006) for further details

The REGREF database provides also a summing index that is a weighted mean of the four different time series. This series, called *Aggregate Gas Regulatory Indicator (AGRI)*, has not been used in our regression because we were interested in understanding the impact of each component on consumers' satisfaction with prices and quality. Table A1 highlight the exact computation mechanism of this aggregate index.

Table A1: Components of the Aggregate Gas Regulatory Index

Index	Weight	Sub-Index	Weight
Entry Regulation	1/4	1. terms and conditions of third party access (TPA) to the gas transmission grid	1/3
		2. percentage of the retail market open to	1/3
		3. existence of national, state or provincial laws or other regulations restricting the number of competitors allowed to operate in the gas production/import segment	1/3
Public Ownership	1/4	1. ownership structure of the largest companies in the production/import sector	1/3
		2. ownership structure of the largest companies in the gas transmission sector	1/3
		3. ownership structure of the largest companies in the gas distribution sector	1/3
Vertical Integration	1/4	1. degree of vertical separation between gas production/import and the other segments	½
		2. degree of vertical separation between gas supply and the other segments of the	3/10
		3. existence of vertical separation between distribution and gas supply.	1/5
Market Structure	1/4	1. market share of the largest company in the gas production/import stage	1/3
		2. market share of the largest company in	1/3
		3. market share of the largest company in the gas supply stage.	1/3

Source: Regref database

Ultimi Contributi di Ricerca CRENoS

I Paper sono disponibili in: http://www.crenos.it

08/15 *Oliviero A. Carboni* "The Effect of R&D Subsidies on Private R&D:Evidence from Italian Manufacturing Data"

08/14 *Gerardo Marletto* "Getting out of the car. An institutional/evolutionary approach to sustainable transport policies"

08/13 *Francesco Lisi, Edoardo Otranto,* "Clustering Mutual Funds by Return and Risk Levels"

08/12 *Adriana Di Liberto, Francesco Pigliaru, Piergiorgio Chelucci,* "International TFP Dynamics and Human Capital Stocks: a Panel Data Analysis, 1960-2003"

08/11 *Giorgio Garau, Patrizio Lecca,* "Impact Analysis of Regional Knowledge Subsidy: a CGE Approach"

08/10 *Edoardo Otranto,* "Asset Allocation Using Flexible Dynamic Correlation Models with Regime Switching"

08/09 *Concetta Mendolicchio, Dimitri Paolini, Tito Pietra,* "Investments In Education In A Two-Sector, Random Matching Economy"

08/08 *Stefano Usai,* "Innovative Performance of Oecd Regions"

08/07 *Concetta Mendolicchio, Tito Pietra, Dimitri Paolini,* "Human Capital Policies in a Static, Two-Sector Economy with Imperfect Markets"

08/06 *Vania Statzu, Elisabetta Strazzera,* "A panel data analysis of electric consumptions in the residential sector"

08/05 *Marco Pitzalis, Isabella Sulis, Mariano Porcu,* "Differences of Cultural Capital among Students in Transition to University. Some First Survey Evidences"

08/04 *Isabella Sulis, Mariano Porcu,* "Assessing the Effectiveness of a Stochastic Regression Imputation Method for Ordered Categorical Data"

08/03 *Manuele Bicego, Enrico Grosso, Edoardo Otranto,* "Recognizing and Forecasting the Sign of Financial Local Trends Using Hidden Markov Models"

08/02 *Juan de Dios Tena, Edoardo Otranto,* "A Realistic Model for Official Interest Rates Movements and their Consequences"

08/01 *Edoardo Otranto,* "Clustering Heteroskedastic Time Series by Model-Based Procedures"

07/16 *Sergio Lodde,* "Specialization and Concentration of the Manufacturing Industry in the Italian Local Labor Systems"

07/15 *Giovanni Sulis,* "Gender Wage Differentials in Italy: a Structural Estimation Approach"

07/14 *Fabrizio Adriani, Luca G. Deidda, Silvia Sonderegger,* "Over-Signaling Vs Underpricing: the Role of Financial Intermediaries In Initial Public Offerings"

07/13 *Giovanni Sulis,* "What Can Monopsony Explain of the Gender Wage Differential In Italy?"

07/12 *Gerardo Marletto,* "Crossing the Alps: Three Transport Policy Options"

07/11 *Sergio Lodde* "Human Capital And Productivity Growth in the Italian Regional Economies: a Sectoral Analysis"

07/10 *Axel Gautier, Dimitri Paolini,* "Delegation, Externalities and Organizational Design"